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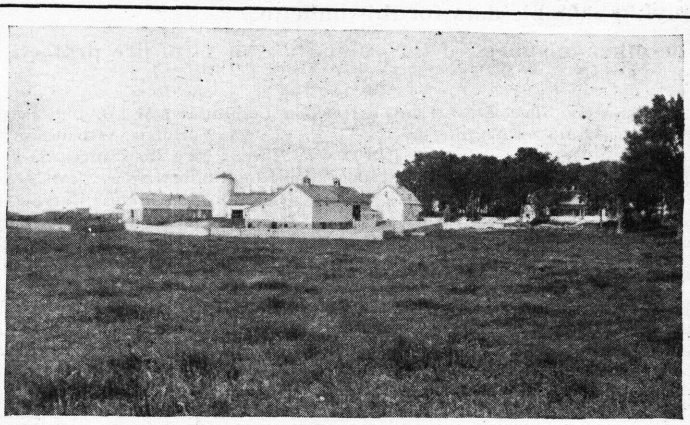
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1590

FIRE-PROTECTIVE CONSTRUCTION *on the* FARM



THE large annual loss on farms and in rural communities, which has been estimated to be as high as 3,500 lives and $150,000,000 worth of property, is a direct challenge to everyone interested in and concerned with conservation of the national wealth and resources.

The United States Department of Agriculture, in an effort to reduce this extensive loss, is studying the causes of farm fires and devising ways and means of control and prevention. In this work the department is actively cooperating with a number of organizations and associations interested in fire prevention.

One of the most valuable contacts is that with the National Fire Protection Association, with executive offices at 60 Batterymarch Street, Boston, Mass. This association, which is the internationally recognized body for setting up standards and making regulations pertaining to the prevention, control, and extinguishment of fire officially approved the publication of this bulletin at its 1928 annual meeting.

David J. Price, as chairman, and Harry E. Roethe, as secretary, Bureau of Chemistry and Soils; M. C. Betts, Bureau of Public Roads; and V. N. Valgren, Bureau of Agricultural Economics, are representatives of this department on the farm fire protection committee of the National Fire Protection Association, which assisted in carrying on investigations and in supplying valuable data for this bulletin.

The other members of the committee on farm fire protection are:

G. L. BENNETT, Sheet Steel Trade Extension Committee; W. D. BRINCKLOE, American Institute of Architects; HARRY P. COOPER, National Association of Mutual Insurance Companies; C. P. FAUNCE, Mutual Fire Insurance Association; CLARENCE GOLDSMITH, National Board of Fire Underwriters; I. D. Goss, Farm (Insurance) Association; S. H. INGBERG, United States Bureau of Standards; ROBERT A. JONES, National Association of Farm Equipment Manufacturers; H. R. KIBLER, American Farm Bureau Federation; R. G. KIMBELL, National Lumber Manufacturers' Association; GEORGE F. LEWIS, Association of Canadian Fire Marshals; T. F. LAIST, American Society of Agricultural Engineers; CHARLES H. MEIGS, Fire Equipment Manufacturers' Institute; E. R. STOTTS, Lightning Rod Manufacturers' Association; VICTOR H. TOUSLEY, National Fire Protection Association; C. R. WELBORN, Underwriters' Laboratories.

The original report of the committee, which forms the basis of this bulletin, was prepared by M. C. Betts, assisted by G. L. Bennett, T. F. Laist, E. B. Mount, and Clarence Goldsmith.

Washington, D. C. Issued April, 1929

FIRE-PROTECTIVE CONSTRUCTION ON THE FARM

Prepared by the *Bureaus of Chemistry and Soils, Public Roads,* and *Agricultural Economics,* in cooperation with the *National Fire Protection Association*

CONTENTS

INTRODUCTION

THE STATISTICS published each year on the annual loss of life and property in farm fires should cause the owner of farm property to stop and think and then proceed to provide, as far as is practicable, against the possibility of his own loss being included in the annual report of the State fire marshal. But the average farm owner is like the average man in other walks of life, in that such figures mean little to him and he has a sublime faith in his own immunity from disaster. His neighbors' buildings may go up in smoke, there may be a fire somewhere in the country every few minutes, but "it won't happen to him." If fire were possible only through his own acts, this attitude of mind might be justifiable, but he should remember that when driving his automobile he has every confidence in his own ability as a driver, but he is not nearly so sure of the other fellow. Likewise, with respect to the possibility of fire he may be careful himself, but he should not put too much confidence in the other fellow, who may be a hired man, with little responsibility; a tramp, with less; or a member of his own family, particularly a child. Nor should he count too much upon immunity from fire caused by lightning, high wind carrying embers from a brush or other fire, spontaneous ignition, or by any other agency.

Fires in farm buildings may be owing to any one of a number of causes, and nothing short of the most fire-resistive materials in construction and furnishings will insure against great loss once a fire is started. Such protection on the farm is not yet generally practicable, but it is possible to provide effective safeguards against the starting and spreading of fire. The construction of farm buildings is not governed by restrictions such as those in effect in cities

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and towns that have building ordinances. Every farm owner is his own building inspector and is responsible for any construction that constitutes a fire hazard. Most farm buildings are beyond the effective reach of public fire-fighting equipment and yet are entirely lacking in fire-resistive features or fire-extinguishing devices.

It is the purpose of this bulletin to point out the fire hazards generally found in farm-building construction and to suggest how they may be avoided in new buildings or remedied in existing structures. It deals chiefly with construction which, if neglected or faulty, might contribute to the spread of fire.

The fire preventive and protective measures suggested herein add somewhat to the cost of structures such as those generally found on farms, but in the opinion of experts who after careful study have prepared these recommendations the cost is fully justified by the resulting benefits. Every precaution should be adopted in order that loss of life and property may be minimized in case of fire, but provision should also be made to prevent the starting of fire from such causes as defective chimneys and smoke pipes, lightning, incorrectly installed electrical or gas lighting systems and appliances, and heating equipment. Every property owner owes this much to himself and to those for whom he is responsible.

Fire insurance can not take the place of fire prevention in the form of proper construction of buildings and safe installation or elimination of hazardous equipment, for whereas insurance provides aid in replacing property destroyed by fire, successful fire prevention does away with fire altogether. Insurance seldom covers the loss of time, the loss of business, or the inconvenience caused by a serious fire. It can not replace valuable records or possessions prized for their association, and no amount of insurance would compensate for even one life lost in the burning of the home. Lives are lost in that way—entirely too many of them.

LOCATION OF BUILDINGS

Time saved in doing the daily chores in and around farm buildings is a factor affecting farm income and accounts for the tendency to arrange the various buildings as compactly as may be consistent with the requirements of the farm operations. On the other hand too little distance between buildings is a very important factor affecting farm expense through heavy fire losses. Because of the many conditions to be considered it is not possible to prescribe any one layout applicable to any number of farms from the standpoint of either efficient operation or fire hazard.

The separation of all farm buildings by distances that completely insure against the spread of fire from one to another is impracticable. The ignition of a frame structure by heat radiated from a large fire, such as a barn filled with hay, would be a practical certainty at a distance of less than 50 feet and might occur at 100 feet or more. Information gathered over a long period of years indicates that there is practical security from exposure fires in a clear space of 150 feet between major structures.

It is desirable that the dwelling be segregated from the other farm buildings for several reasons. It permits of the development of

attractive surroundings and tends to separate the home life from the business of the farm. The relative positions of the farm house and barn should be such that the prevailing wind will not blow from the one to the other, but across a line between the two. Thus unpleasant odors will not be carried from barn and yards toward the house nor sparks from either to the other.

In some parts of the country where the winters are severe, particularly in New England, it has been the custom to connect the dwelling and barns, with other outbuildings, directly or by short covered passages. The reason for this arrangement is, of course, the protection from the weather which it affords, but it means a practical certainty of total loss of the major buildings in case of a fire. If such protection from the weather is insisted upon, the buildings should be well separated, and the connecting passages should be provided with a fire barrier at the center consisting of a masonry or metal partition and a metal-covered self-closing door. If the roof is of frame construction the partition should extend through and at least 18 inches above it.

On many small farms most of the livestock, if not all of it, and often the crops, are housed under one roof. This may be economical and entirely permissible farm management for a small industry, but when there are many animals to be cared for it is better for the stock and also better management, to house the different kinds in separate quarters. It is desirable that all quarters have ample air and sunlight. This arrangement, with provision for ample lots, generally provides a reasonable safeguard against the spread of fire from one building to another, at least between the larger and more important structures.

The smaller and more hazardous buildings, such as the shop, garage, smokehouse, and incubator room, should be placed as far from other structures as reasonable convenience will permit and, where possible, in such positions that the prevailing wind will carry sparks away from other risks.

The best insurance against the spread of fire from one building to another is to provide structural safeguards, such as are herein recommended, in all buildings. A safe chimney in one of two buildings containing heating units is but half insurance. Safe chimneys in both buildings eliminate the risk of fire from defective chimneys. Simplicity of exterior design reduces the exposure hazard, since projections, such as eaves, cornices, porches, and dormers, afford greater opportunity for ignition from a near-by fire than do plain surfaces.

FARMHOUSES

The frequency of fires in farm dwellings is owing to the fact that there is usually more activity in the house, more opportunity for hazardous conditions, and consequently there are more chances for the starting of fire. A few comparatively inexpensive preventive measures incorporated at the time of building, or installed later, and caution in the use and care of flammable material will greatly reduce the chances of disastrous property loss and, far more serious, that of life.

THE CELLAR

Many fires originate in house cellars in which heating apparatus has been installed without proper safeguards, or in which material of flammable nature has been stored. The best means of prevention is the proper installation and safeguarding of heating and lighting equipment and the rigid exclusion of flammable materials which might be ignited by faulty heating or lighting equipment, spontaneous combustion, or the open flame of match, lamp, or lantern. No kind of building construction will prevent the starting of fire in a cellar, but the construction of the building should be such that in case a fire does start it will not spread rapidly through the house, thus increasing the chances of its being extinguished before great damage is done.

Cellar walls should be, and generally are, of masonry of sufficient strength to support the upper structure without settling, but the inner supports, such as posts and girders, are not always equally substantial. The more fire resistant the supporting members, the smaller the chance of quick collapse of the upper floors in case of a cellar fire. Masonry piers, or walls, and heavy wooden girders should be employed to support floors and partitions. Steel columns and girders are better from the construction standpoint, but unless they are protected with an incombustible covering a hot cellar fire may soon cause them to buckle and possibly open up the floors and partitions, permitting rapid spread of the fire.

Wooden posts should be solid and heavy, not less than 8 inches in the least dimension, and should rest on ample concrete or masonry footings extending at least 4 inches above the cellar floor, as a protection against ground moisture, which may cause rapid deterioration. In some localities wood in contact with or close to earth may become infested with boring insects that soon destroy the interior, leaving but a shell with little strength and readily weakened by fire.

Wooden posts and girders should be of a size considerably greater than that necessary to carry the weight imposed upon them so that, should they be exposed to flame, a portion of the exterior surface could be burned away without weakening the member to the point of failure. The wood should be straight grained and free of sapwood, shakes, unsound knots, rot, or wormholes. Posts and girders should be creosoted or soaked in a zinc-chloride solution to prevent rotting and attack by boring insects.

Girder and joist ends inclosed in masonry which is damp with ground or exterior moisture are subject to rapid rotting. All cellars should be well ventilated, and the construction should be such as to insure the dryness essential to the health of the occupants of the dwelling and to the preservation of the wood employed in the construction. Farmers' Bulletin No. 1572, Making Cellars Dry,[1] contains valuable information on this subject.

There should be sufficient headroom in the cellar to permit of the installation of heating equipment as described later. When heat-

[1] The following publication may be obtained upon application to the Office of Publications, Department of Agriculture, Washington, D. C.: WARREN, G. M. MAKING CELLARS DRY. U. S. Dept. Agr. Farmers' Bul. 1572. (In press.)

ing units are installed in existing cellars it is sometimes necessary to place the heater in a shallow pit in order to obtain the desired headroom.

CUT-OFF FOR CELLARS

Because of the hazardous nature of the contents of most cellars, such as heating and lighting equipment, fuel, and accumulations of flammable material, and the fact that a fire in the cellar may not be detected until it has grown to serious proportions, it is well to employ construction that will confine the fire as long as possible to the place of origin. A floor of fire-resistive construction above the cellar would afford the best protection, but because of the cost it may not be practicable for the average farmhouse.

Effective protection against the rapid passage of fire from a cellar through the floor above is afforded by joists not less than 1⅝ inches thick [2] ceiled on the under side with expanded metal lath not lighter than 25 gage, weighing 3.3 pounds per square yard, and plastered to ¾-inch grounds with fibered or sanded gypsum plaster or Portland-cement plaster; or the joists may be covered with strong fire-resistive plaster board not less than one-half inch thick and then coated with ¼-inch gypsum plaster. The ceiling should be finished tight against the outer walls, wooden sills, and girders. The walls and ceiling of cellar stairways should be finished in the same manner. The flooring on top of the joists should be double, with building paper between the layers, to provide an extra barrier should the lower protection fail at any point. A floor of this kind greatly lessens the passage of ash and other dust from the cellar to the rooms above, and so makes the housekeeper less work.

FIRE STOPPING

The open spaces between the studs of a frame wall, between the furring strips of a furred masonry wall, and between floor joists act as chimneys when fire gets into them, which does not take long in the average house. Thus hot gases and smoke, followed quickly by flame, are rapidly spread from one part of a building to another. Fire in such places is difficult to put out even when discovered before great damage is done. Gases and smoke carried in this way may overcome sleeping persons.

To prevent or retard the spread of fire from the room in which it starts, the use of fire stopping is recommended. Fire stopping consists of blocking off all openings or passages in walls and floors with wooden blocks or, preferably, incombustible material supported on metal.

The added cost of such protection is not great, yet its value is so little appreciated that the average dwelling has no fire stopping at all. Though it does not require a high degree of mechanical skill, fire stopping must be well done or much of its protective value is lost.

Wooden fire stops often require better workmanship than those of incombustible materials because odd ends of timber may be used for the purpose and the tendency is to consider a fit "good enough" if the piece is one-fourth or one-half inch short of the correct length

[2] American lumber-standard size for nominal 2-inch thickness.

or is not cut square on the ends. Sometimes a joist or stud is not set squarely or is warped, and unless the stopping is cut to fit neatly an opening is left which greatly reduces the value of the protection, since tight joints are necessary to prevent the passage of air or gases heated to the point of combustion.

Defects in the fitting of wooden stopping may be offset to a considerable extent by using wood 2 inches thick and covering the top of the stopping with a 3 or 4 inch layer of incombustible material, such as broken-up refuse mortar or plaster, mineral wool, concrete, old brick, cinders, or a mixture of sand and gravel. The loose material will settle and tend to fill spaces caused by poor workmanship or shrinkage of the timber. A 1-inch layer of cement or lime mortar on top of the wooden stopping prevents the shifting of the finer pieces of loose material.

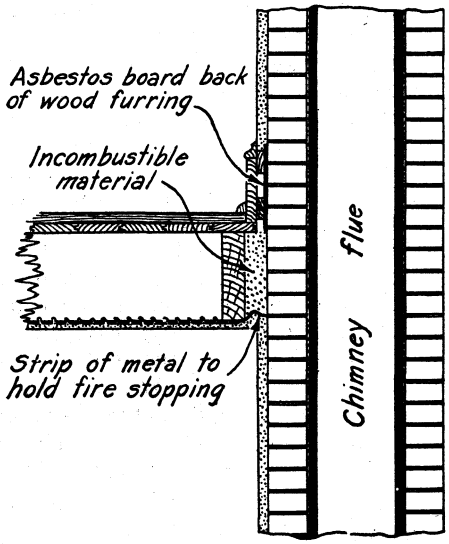

FIGURE 1.—Fire stopping around chimney and protection for woodwork placed next to plaster on chimney brickwork

Strips of metal lath or sheet metal are preferable to wooden supports. The metal is in itself incombustible and is more easily installed because accurate cutting of the ends is not necessary, since they may be bent up and nailed. They will also adapt themselves to any shrinking or twisting of the studs and joists. To prevent sifting of the finer pieces of loose material through metal lath, the metal should be covered with a layer of lime or cement mortar.

All wooden construction adjacent to chimneys should be insulated and fire stopped. A space of 2 inches should be left between the outside face of a chimney or fireplace and all wooden beams or joists. This space should be filled with some porous incombustible material, such as those mentioned above, which will allow of expansion and contraction of the brickwork. Solid brickwork, concrete, or mortar should not be used. The filling should be done before the flooring is laid.

Baseboards or skirting fastened to plaster which has been applied directly to chimney masonry should be protected with a layer of fire-resistive material, such as asbestos board, at least one-eighth inch thick between the woodwork and the plaster.

Wooden studding, furring, or lathing never should be placed against a chimney but should be set back at least 2 inches from the chimney masonry. This construction is a protection against fire, and in addition it prevents cracking of the plaster owing to expansion and contraction or settlement of the chimney.

CONSTRUCTION OF FIRE STOPPING

Methods of fire stopping in various forms of wall, floor, and partition construction are shown in Figures 1 to 9, inclusive. Although only incombustible material is recommended for fire stopping, it may not always be practical to use it, and some of the sketches therefore indicate both wooden and incombustible stopping.

There are some places in wooden construction, such as shown in Figure 5, *D* and *E*, where wood or compressible incombustible material should be used, as otherwise the shrinkage of timbers may cause bulging of construction in contact with the fire stopping.

Although it would not be practicable to fire stop a house already built as completely as is here recommended for new structures, it is feasible to apply several of the suggestions and thus materially lessen the fire risk.

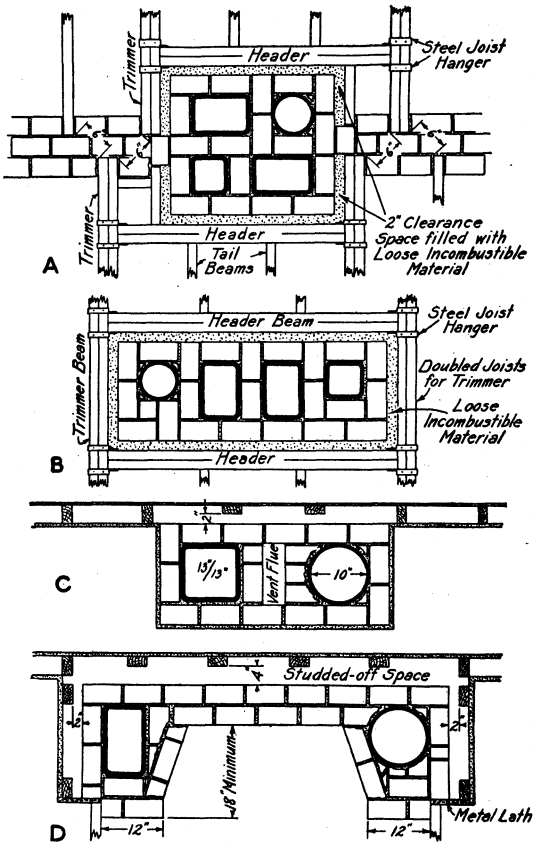

FIGURE 2.—Floor framing around chimney in brick or other masonry partition to obtain proper spacing between ends of floor joists; *B*, ordinary floor framing around a chimney; all timbers 2 inches clear of brickwork and spaces filled with loose incombustible material; *C*, stud partition across back of a chimney, showing proper method of arranging studs; *D*, stud partition across back of a fireplace and around the ends of the chimney breast, showing proper arrangement of studs; method of fire stopping this space is shown in Figure 3

ROOFING

The roof covering of all farm buildings, with the possible exception of small detached temporary structures the contents of which are of small value, should be chosen with careful consideration of the real cost and the protective properties. The first cost is of less importance than the cost per year of service. The fire-resistive value can not always be judged by examination of samples of new roofing materials, since some roof coverings change in appearance and in fire-resistance after a short time of service. Unless reliable information can be obtained concerning the fire-resistive value of a roofing under consideration it would be well to use some other roofing known to be fire resistive, even though the cost is somewhat greater.

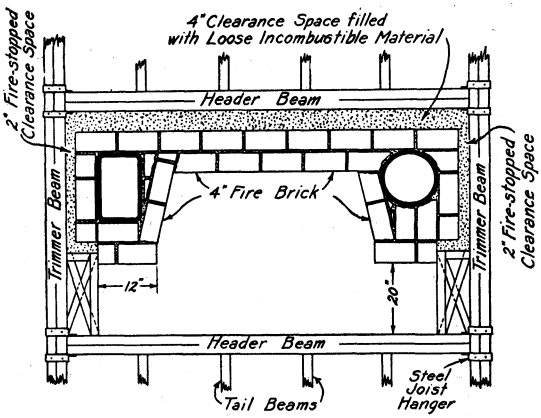

FIGURE 3.—Floor framing around a single fireplace. Note filling between framing and brickwork, which serves both as insulator and fire stop

Fire-resistive roof coverings should be used wherever possible. There are a variety of roofings on the market which afford satisfactory protection and service. The life of the best fire-resistive roofings, such as tile, metal, or slate, is considerably longer than that of some of the less resistive materials. Other roofings that afford satisfactory protection are asbestos shingles, heavyweight composition shingles, and prepared roofings which have been tested and proved fire resistant and durable. Asphalt prepared roofings should conform to the requirements of Federal specifications,[3] the specifications of the American Society for Testing Materials, or the Underwriters Laboratories class A, class B, or class C standards. A statement should be obtained from the manufacturer to the effect that the roofing purchased conforms to one of these standards.

Wooden shingles have a number of points in their favor from utility and architectural standpoints, but when old and dry they can be set afire by chimney sparks or brands from another fire, and when burning generate flying brands which may be carried considerable distances and ignite the roofs of other buildings. When wooden shingles are to be used the best grade, preferably edge-grained, and good workmanship should be insisted upon.

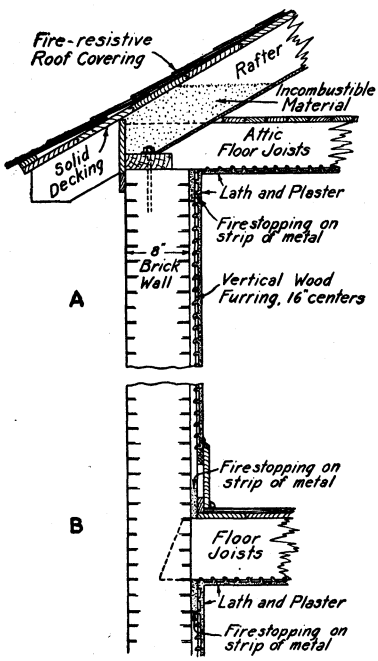

FIGURE 4.—*A*, Method of fire stopping at eaves when attic floor joists are level with plate; *B*, method of fire stopping above and below floor joists

STAIRWAYS

Loss of life in farmhouse fires is often the result of the victims being trapped on an upper floor, the one stairway being impassable because of fire or smoke. A second stairway, in

[3] An index of the United States Government Master Specifications may be obtained, without charge, upon application to the Federal Specifications Board, care of the Bureau of Standards, Washington, D. C.

another part of the house, may well be worth the additional cost in case of fire.

The spaces between the carriages of all stairways should be fire stopped with metal or heavy wooden blocking at top and bottom. If the stairway passes through a partition there should be additional stopping so placed as to prevent the passage of fire from one room to another.

Open stairs leading from one floor to another, and particularly from a hall or room having wide doorless openings into other rooms, are a great menace in case of fire. Hot, gas-laden air from below rushes up the stairway, which acts as a chimney, imperils the lives of those above and causes rapid spread of fire. Open stairways and wide openings between hall, living room, and dining room are frequently desirable for effect, yet for fire protection it is much better that the stairway be cut off by inclosing partitions, with a door at the bottom or top if not at both top and bottom. In houses heated by so-called pipeless or one-register furnaces, however, closed stairways generally are not practicable.

Cellar stairways should be closed at the top with a metal-clad or heavy wooden door.

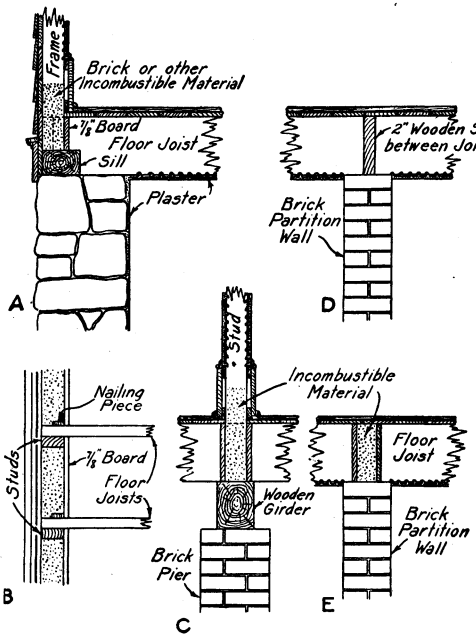

FIGURE 5.—*A* and *B*, Vertical and plan sections, showing fire stopping in wall of frame building at sill and between studs and floor joists; *C*, fire stopping in partition resting on wooden girder; *D*, fire stopping with timber cut between floor joists on top of brick partition; *E*, same as *D*, except that incombustible compressible material between two boards is used instead of timber. Wherever boards are indicated as supports to hold incombustible fire stopping in place metal is recommended as a superior substitute. It is more easily installed and will not burn

CONSTRUCTION OF CHIMNEYS

One of the most common single causes of farm fires is the defective chimney, including flues and stovepipe connections. The term "defective" applies to many of the conditions found in average house chimneys. Proper chimney construction is a most important structural feature and will do much in reducing the chance of fire. If the following suggestions are carefully carried out the risk of fire caused by chimneys will be practically eliminated.

The walls of all chimneys, whatever the fuel used, should be built of brick, stone, reinforced concrete, or hollow units of clay or concrete as described in the following paragraphs and as illustrated in Figures 2, 3, 10, and 11.

The minimum thickness of chimney walls not more than 30 feet high should be 4 inches for brick, 4 inches for reinforced concrete,

8 inches for hollow tile, and 12 inches for stone. All such chimneys should be lined in the manner described in the following paragraphs.

Brick chimneys should be built only of sound, hard-burned brick. Concrete chimneys cast in place should be suitably reinforced vertically and horizontally to prevent cracking. Quartz gravel should not be used in concrete for chimneys.

Flue linings of fire clay or vitrified clay not less than three-fourths inch thick should be used in all chimneys except those having walls of reinforced concrete not less than 6 inches thick and chimneys with brick walls not less than 8 inches thick, although in the latter lining is desirable. Flue linings protect mortar joints and bricks or tile from the destructive effects of flue gases and prevent cracks in the masonry caused by changes in temperature. Lined flues are more easily cleaned.

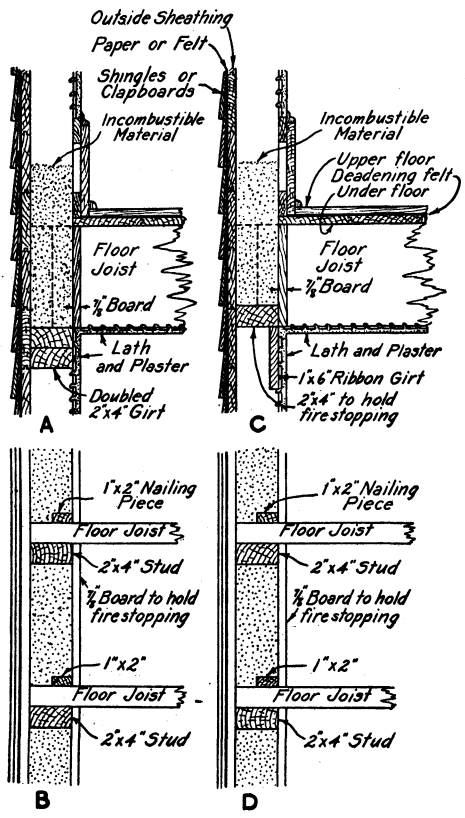

FIGURE 6.—*A* and *B*, Vertical and plan sections, showing fire stopping in frame wall at connection of upper floor joists with girt; *C* and *D*, fire stopping at same place for balloon frame

Mortar used in setting flue linings and in all masonry above the roof or otherwise exposed to the weather should consist of 1 part Portland cement and 3 parts clean sand, to which may be added not more than 10 per cent hydrated lime or 9 pounds of lime to each bag of cement. Mortar for all other portions of chimney masonry may be of 1 part Portland cement, 1¼ parts hydrated lime, and 6 parts clean sand. Slaked-lime putty dissolved in the mixing water may be used in place of hydrated lime.

Flue linings should be set with the mortar joints struck smooth on the inside. The masonry should be laid up around each section of the lining after it has been set in place. All joints in the masonry should be filled with mortar, and spaces between the masonry and lining should be thoroughly slushed and grouted full with mortar and spawls as each course of masonry is laid. No cracked, broken, or otherwise defective linings should be used. Linings should start from a point not less than 8 inches below the center line of smoke-pipe intakes. Any hollow space below this point should be closed with solid masonry to prevent soot accumulation below. In fireplaces the lining should start from the apex of the smoke chamber

(Fig. 10) and should be continuous to the height required. No smoke-pipe intake should be cut into a flue lining already set in place, as the lining may be cracked or broken and the damage not detected. A starting section should be procured or the opening cut before the section is set in place.

Flues should be built as nearly vertical as possible and in no case at an angle greater than 30° from the vertical. Where flues change direction, the abutting linings at the angle joints should fit closely, and at no point should the cross-sectional area be reduced.

Not more than two lined flues should be permitted in the same flue space, and the joints of any such adjoining flue linings should be staggered at least 7 inches. When there are more than two flues in a chimney, at least each third flue should be separated from the others by a smoke-tight withe or division wall of masonry or concrete not less than 4 inches thick and bonded into the chimney walls. Each flue intended for a heating furnace or boiler connection, or for a fireplace, should be separated from other flues by such a withe. (Fig. 10.)

Chimneys should be built upon concrete or solid-masonry foundations properly proportioned to carry the weight imposed without danger of settlement or cracking. The footing for an exterior chimney should start below the frost line.

Chimneys in frame buildings should always be built from the ground up or rest on masonry basement or foundation walls. Chimneys should not rest upon or be carried by wooden floors, beams, or brackets, nor be hung or supported by metal stirrups from wooden construction.

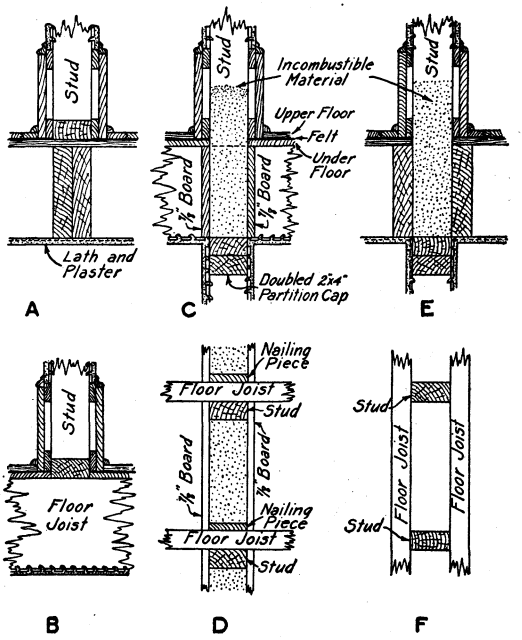

FIGURE 7.—*A*, Interior partition running in same direction as floor joists, supported on double joists, fire stopped at bottom by 2 by 4 inch sole; *B*, partition running crosswise to floor joists, resting on sole used as a fire stop; this would be improved by addition of incombustible material on top of sole; *C* and *D*, vertical and plan sections, showing partition running crosswise to joists, resting on doubled 2 by 4 inch cap of partition below, showing method of fire stopping between joists; *E* and *F*, vertical and plan sections, showing partition running in same direction as floor joists, and resting on doubled 2 by 4 inch cap of partition below, used as a fire stop, with floor joists placed alongside studs

Chimneys partly supported by corbels or masonry brackets should not rest on hollow walls or walls of hollow units. Solid walls supporting corbeled chimneys should be not less than 12 inches thick, and the corbeling should be of brick projecting not more than 1 inch per course and not more than 6 inches in any case.

Connections between chimney and roof should be made with sheet-metal cap and base flashings arranged to allow for vertical or lateral movement between chimney and roof. (Figs. 10 and 11.) For the same reason no increase of chimney-wall thickness, projecting masonry, or setback should be permitted within a distance of 6 inches above or below the rafters or roof joists.

Chimneys should be built at least 3 feet above flat roofs and not less than 2 feet above the ridge of gable and hip roofs, irrespective of the distance of the chimney from such ridge.

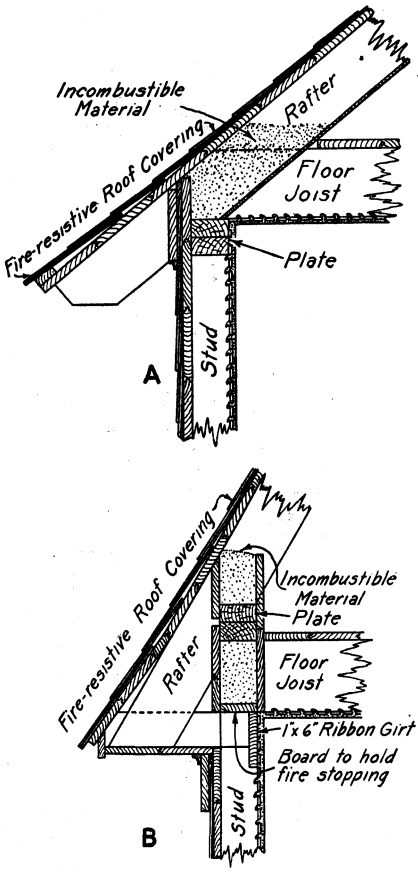

FIGURE 8.—*A*, Connection of floor joists with outside frame at plate level, showing open rafter ends and fire stopping; *B*, connection of floor joists with outside balloon frame; method of fire stopping cornice and gambrel roof construction

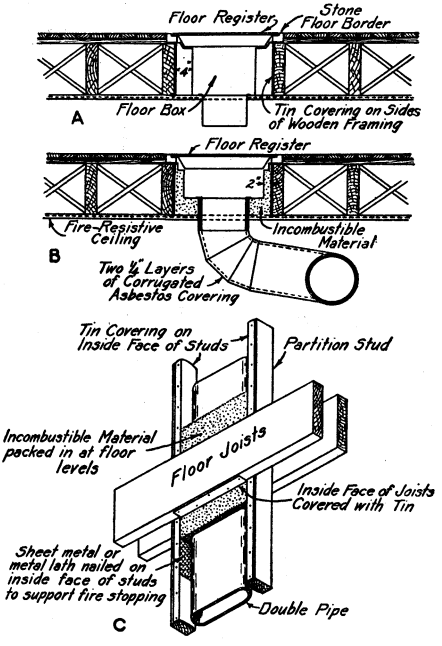

FIGURE 9.—*A*, Method of fire stopping around floor register; note register box extended to line of ceiling protection, which simplifies installation; *B*, a more complete method of fire stopping and one well suited to existing buildings; *C*, method of fire stopping between floor joists around a warm-air pipe carried up in a partition.

Unless the top of the chimney masonry is otherwise protected, the flue lining or linings should project above the masonry not less than 4 inches and should be incased in a cement mortar cap, as shown in Figure 10.

There should be but one heating unit connected to any one flue, irrespective of the fuel used.

The size of the chimney flue is a factor in fire prevention, in that an unnecessarily large flue permits too rapid cooling of the flue gases and too small a flue results in incomplete combustion of fuel. In

either case soot is deposited in the flue and becomes a possible source of a serious fire.

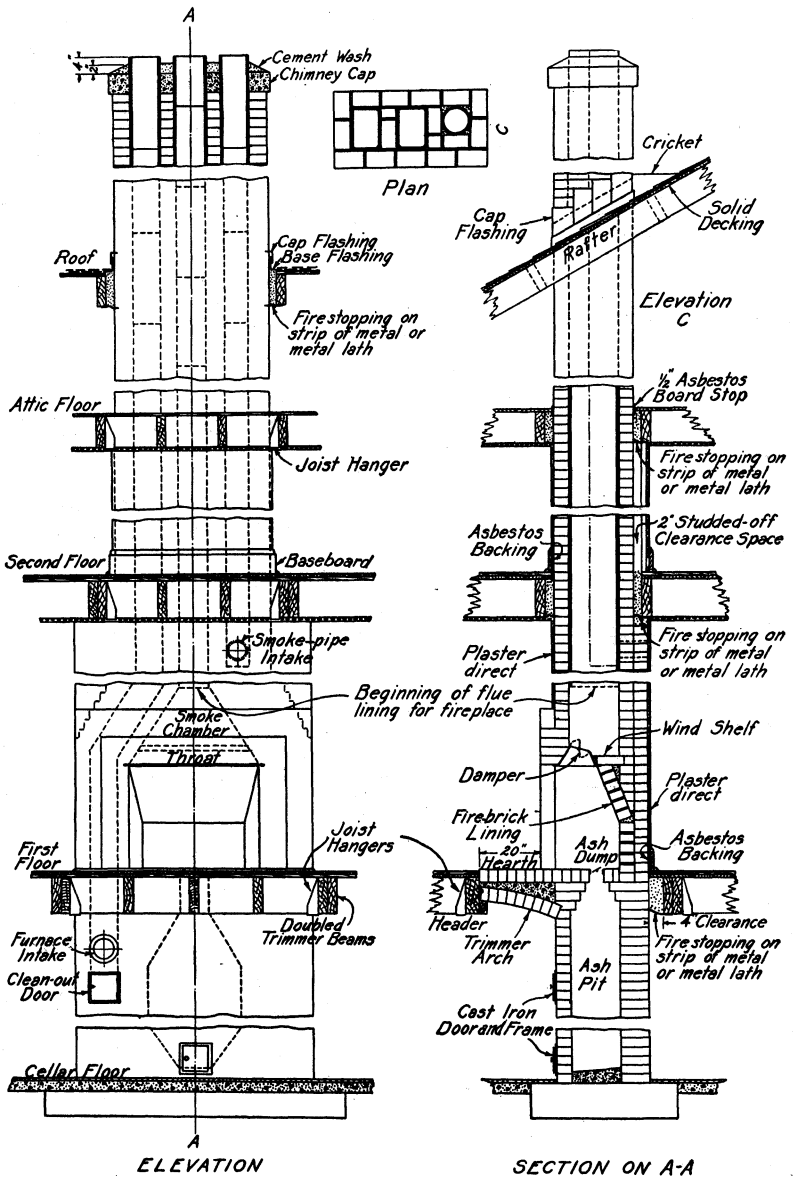

FIGURE 10.—Recommended chimney construction

For stoves and ranges, flues of ordinary height, as found in houses of 1 to 3 stories, should be not less than 6 inches inside diameter round lining; 7½ by 7½ inches, outside dimensions, rectangular lining; or 8 by 8 inches, inside dimensions, unlined.

Flues for ordinary fireplaces should be 8 inches, inside diameter, round lining; 8½ by 13 inches, outside dimensions, rectangular lining; or 8 by 12 inches inside dimensions, unlined.

The proper size of flue for warm-air furnaces and heating boilers depends upon the size of the heating unit. In planning new or remodeled heating equipment it is well to determine the type and size of heater to be installed and then to provide a flue of cross-sectional area at least equal to that of the smoke pipe. As a general rule, flues for house heaters and furnaces should be of the size recommended for fireplaces. No furnace or heater flue should be less than 8 inches, inside diameter, round lining; 8½ by 8½ inches, outside dimensions, rectangular lining; or 8 by 12 inches, inside dimensions, unlined.

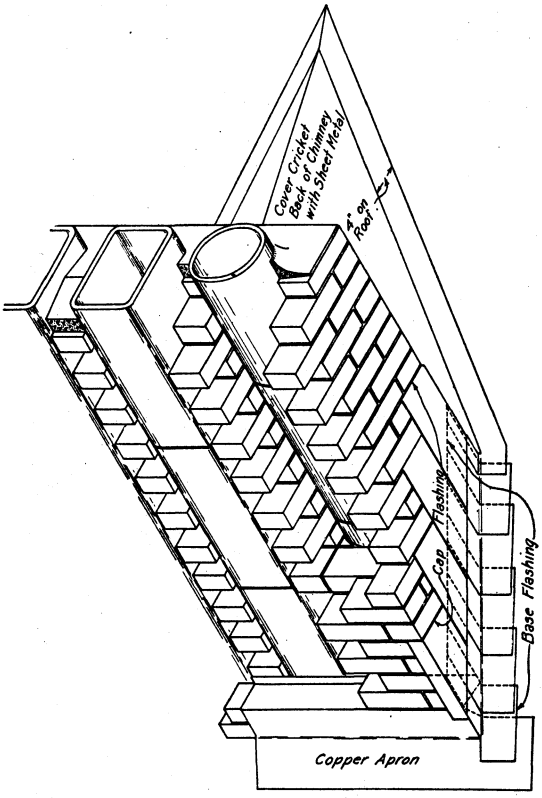

FIGURE 11.—Chimney construction, showing method of flashing at roof surface, also a wash course surrounding flues at top

After a chimney has been completed all flues and intake openings should be thoroughly cleaned and left smooth on the inside.

SMOKE TEST FOR LEAKAGE

Every flue should be subjected to a smoke test before the heater is connected with it. This may be done as follows: Build a paper, straw, wood, or tarpaper fire at the base of the flue and when the smoke is passing in a dense column tightly block the outlet at the top by laying a wet blanket over it. If leakage exists at any point it will become apparent by the appearance of smoke at the opening. Flues so tested frequently reveal very bad leaks into adjoining flues or directly through the walls or between the linings and the wall. When the smoke test indicates leakage, the defect should be remedied before the chimney is accepted for use. Remedying such defects is usually difficult, hence it is wise to watch the construction closely as it progresses. Although many brick masons say that all flues leak, this is not true; every flue should be tight.

CHIMNEY CONNECTIONS

Proper care in setting and looking after smoke-pipe connections with chimneys would greatly lessen the number of fires chargeable to defective construction.

In fitting the smoke pipe no opening should be left around it, and the pipe should not project into the flue beyond the inner face of the lining. The joint should be made air-tight by a closely fitting collar and boiler cement. If the pipe extends into the flue a shelf is formed on which soot may accumulate, the flue area will be reduced, and a poor draft may result.

Smoke pipes should enter the chimney horizontally, and the connection through the chimney wall to the flue should be made with fire-clay or metal thimbles securely and tightly set in the masonry. No wood should be permitted within 6 inches of thimbles or any part of the smoke pipe. The space between the thimble and any wood furring should be covered with metal lath and plaster.

When not in use, smoke-pipe openings should be closed with tight-fitting metal covers. If the room is papered the metal covers may also be papered, provided a protective coating of asbestos paper is first applied over the metal. If there is another connection the metal may become hot enough to scorch the unprotected wall paper or set it afire.

No smoke pipe should be permitted within 18 inches of any woodwork unless at least that half of the pipe nearest the woodwork is protected properly by 1 inch or more of fire-resisting covering. A metal casing 2 inches from the upper half of the pipe is sometimes employed to protect woodwork directly above it. When a smoke pipe is so protected it should never be less than 9 inches from any woodwork or combustible material. Wooden boxes, barrels, or other combustible material should not be stored under or near a smoke pipe.

If a smoke pipe must be carried through a wooden partition the woodwork should be properly protected. This can be done by cutting an opening in the partition and inserting a galvanized-iron double-walled ventilating thimble at least 12 inches larger than the smoke pipe (fig. 12) or by surrounding the pipe with brickwork or other incombustible material.

Smoke pipes should not pass through floors, closets, or concealed spaces. They should not enter a chimney in a garret. They should be cleaned at least once a year as described in the bulletin entitled "Clean Your Chimneys," published by the National Fire Protection Association.

FIREPLACES

The walls of fireplaces should never be less than 8 inches thick, and if built of stone the minimum thickness should be 12 inches.

It is advisable that the backs of all fireplaces be lined with fire brick laid in fire clay. When a grate for burning coal or coke is set in a fireplace a lining of fire brick at least 2 inches in thickness should be added to the fire back unless the grate has a solid iron back which provides an air space behind it.

All hearths in front of fireplaces and chimney breasts should be supported by masonry trimmer arches or other fire-resistive con-

struction. Arches and hearths should be at least 20 inches in width, measured from the face of the chimney breast, and should be of brick, stone, terra cotta, or reinforced concrete, not less than 4 inches in thickness. A flat stone may be used to carry the hearth if it is properly supported and a suitable fill is provided between it and the hearth. The length of the trimmer arch and of the hearth should be not less than 24 inches longer than the fireplace opening. Wooden centering under trimmer arches should be removed after the mortar has set.

The construction of fireplaces is illustrated in Figure 10. All open fireplaces should be equipped with a substantial fire screen or spark arrester of incombustible material.

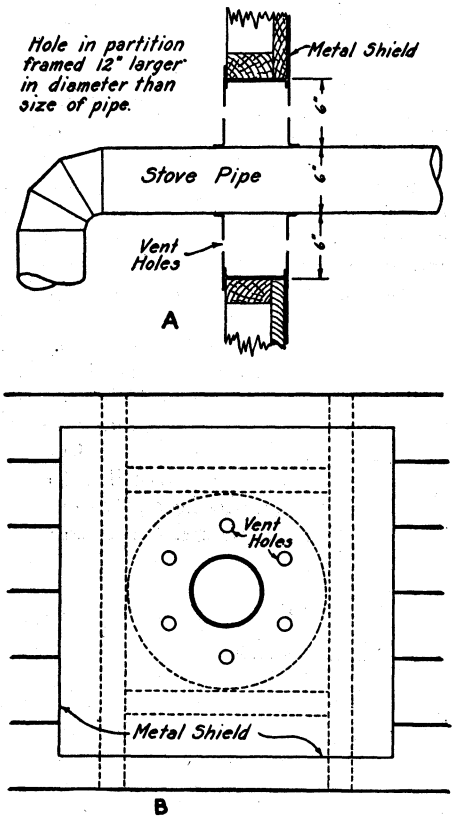

FIGURE 12.—*A*, Sectional view of protection around a stove pipe passing through a wooden partition; *B*, elevation of same protection device

CARE AND REPAIR OF OLD CHIMNEYS

A chimney that becomes too hot to permit holding the hand against it without discomfort is dangerous if woodwork touches it. It should be carefully inspected by a reliable mason and the protection suggested in preceding pages applied.

A smoke test, as described on page 14, is recommended as an excellent means for discovering dangerous holes in chimney walls. If smoke escapes through the chimney walls at any place the chimney should be repointed or rebuilt as conditions may require.

Where soft coal is used it is often necessary to rebuild unlined chimney tops. All unlined chimneys, irrespective of the fuel used, are liable to become defective through disintegration of the mortar joints.

Another means of ascertaining whether chimneys need rebuilding is to inspect them from the top. An electric torch or a lantern let down on a strong cord is an aid in detecting defects. If mortar has begun to fall out from between the bricks, openings will soon develop all the way through the wall, and it is well to test the mortar from the outside with an ice pick or other sharp implement. If it can be pushed through, the following repairs should be made at once: The chimney should be torn down to a point where full solid mortar joints are found and at least 18 inches below the roof. Fire-

clay flue lining, of the same size as the inside measurements of the chimney, should be set in the top of the flue, which should then be built up with good brick and Portland-cement mortar. This will make a solid chimney through the roof where there is greatest danger, and it may be the best that can be done unless the flue portion of the chimney is completely torn down and rebuilt as previously described.

Flues that leak through the joints of the lining may sometimes be improved in the following manner: Using a tightly woven cloth, such as that used in cement bags, make a pad about 1½ inches thick and of a size that will fit the flue tightly. Excelsior or hog hair may be used to fill the pad. On each side of the pad place a 1-inch board cut to the shape of the flue but measuring 2 inches less in each dimension. The boards should be well nailed together through and around the center of the pad. Attach light ropes or wires to each of the corners of each board and bring them together at the center, but at least 12 inches away from the board, and attach ropes long enough to permit drawing the pad up and down the flue. The short ropes or wires attached to the corners of the pad will tend to keep it horizontal. Place the pad in the flue at the top and draw it up and down until the flue is cleaned of soot.

With the pad drawn down to a point just above the smoke-pipe entrance, pour a mixture of 1 part Portland cement and 2 parts sand down the flue from the top, using a few quarts at a time. The pad should then be pulled up and down by means of the top and bottom ropes. The mixture should be of such consistency that it will flatten out on the pad but remain in cracks or openings when forced into them by the passage of the pad. This operation should be continued until the entire length of the flue has been traversed several times and the open joints have been completely closed.

HEATING AND LIGHTING EQUIPMENT

PROTECTION OF BOILERS, FURNACES, AND STOVES

Low-pressure steam or hot-water heating boilers and warm-air furnaces having ash pits in which hot ashes accumulate should rest upon incombustible foundations. This is naturally provided for when such appliances rest upon the earth or concrete floor of a basement or cellar, but in some old houses it may be necessary to place them upon wooden floors. In such case a hearth consisting of a supporting layer of boards, a ⅛-inch layer of asbestos board, and not less than 4 inches of brick or concrete should be built within the thickness of the floor framing so that the top surface of the hearth is flush with the floor. Such hearths should extend at least 12 inches on the sides and back and 24 inches on the front of the furnace, boiler, or similar heating appliance.

Wooden floors under cooking or heating stoves should be protected with a ⅛-inch layer of asbestos board covered with sheet metal of not less than 26 gage. Such protection should extend at least 12 inches at the sides and 24 inches at the front of the heating unit.

No woodwork or wooden lath and plaster partition should be permitted within 3 feet of the sides or back of furnace, range, stove, or other heating appliance unless it is covered with a metal shield or other incombustible material to a height of at least 4 feet above

the floor, in which case the distance should be not less than 18 inches. This covering should extend the full length of the boiler, furnace, or heating appliance and at least 2 feet beyond it toward the front. Metal shields should be so attached as to preserve an air space behind them.

The overhead clearance of boilers and warm-air furnaces should be not less than 15 inches, whatever the construction above may be. Any woodwork within 2½ feet of the top of a boiler or furnace should be protected by a loose-fitting metal shield arranged to preserve an air space between the metal and the wood. If tin is used for this purpose it should have locked joints; soldered joints are not reliable. Much better protection is afforded by the use of some heat-insulating material, such as a double layer of ¼-inch asbestos board covered with metal lath and a coat of cement or asbestos plaster. Instead of the lath and plaster a covering of sheet metal might be used, but it would not be quite so efficient and would be subject to rust.

The protection over a furnace should be in addition to the covering of the entire ceiling as described under "Cellars."

WARM-AIR PIPES AND REGISTERS

Horizontal warm-air furnace pipes should be placed at least 6 inches below wooden floor beams or a wooden lath and plaster ceiling. If the floor beams or ceiling are protected by metal lath and plaster, or covered with loose-fitting tin, or if the pipe is covered with at least one-half inch of corrugated asbestos, the distance from the woodwork may be reduced to not less than 3 inches.

Cold-air ducts for warm-air furnaces should be made of incombustible material for a distance of at least 4 feet from the furnace.

Warm-air pipes in combustible partitions should be securely covered with one-half inch of corrugated asbestos, and the covering should not be within 1 inch of wooden studding. Metal lath should be used to cover the part of the partition in which the pipe is located. The studs on either side of such pipe should be covered with strips of metal loosely attached.

Warm-air pipes placed in wooden partitions and protected as described above should be at least 5 feet, horizontal distance, from the furnace. There is always a possibility of the furnace becoming overheated or a break occurring in the furnace dome, thus permitting direct connection between the fire and the warm-air pipes.

Register boxes should be of metal, and where set in wooden construction should be surrounded by a metal casing attached to the woodwork and having its edge turned under the register border. The distance between the register box and the casing should never be less than 2 inches.

INSTALLATION OF GAS PIPES AND APPLIANCES

Gas and vapor systems of various kinds are used more or less extensively on farms for lighting and other purposes. To minimize the fire hazards, no such systems or device should be installed unless made by a well-established firm whose product has been tested and listed by the Underwriters' Laboratories or other well recognized

authorities. The installation should be made in strict accordance with the manufacturers' directions and with the recommendations of the National Fire Protection Association.[4]

ELECTRICAL INSTALLATIONS

Electricity is one of the safest known sources of light, heat, and power when the installation is properly made, but many fires originating from defective electric installations are insidious, as they occur in hidden places and are not likely to be discovered until beyond control. It is therefore most important that all electrical wiring, apparatus, or appliances for furnishing light, heat, or power shall be in accordance with the National Electrical Code, and that no electrical equipment should be installed except in conformity with this code.[5] Wiring and electrical appliances should be installed only by experienced electricians.

LIGHTNING PROTECTION

There is no question concerning the value of properly installed lightning-protective systems. Although such systems are not considered structural features, no farm building of value should be without them. Such protection should be installed carefully and with full knowledge of approved methods. It should be done only by those experienced in the work. As the subject is one that can not be covered in a few paragraphs it is recommended that the Safety Code for Protection of Persons and Buildings against Lightning, published by the National Fire Protection Association, be followed.

BARNS AND OUTBUILDINGS

BARNS

The barn, like the farmhouse, is a great fire hazard, largely because of the highly flammable contents and the opportunities for starting fires through accident or carelessness. The best protection is in fire-resistive construction—that is, all concrete or other masonry combined with concrete and other fire-resistive materials, and such construction should be employed whenever possible. In the stock barn the greatest source of danger is the hay or straw stored in the mow. In a mow fire, masonry walls and a reinforced concrete or other fire-resistive mow floor would protect valuable stock below for a time sufficient to permit of their safe removal. Mow walls and roofs of incombustible materials, which would completely withstand the heat of a mow fire, generally are out of the question because of the cost, and construction of less fire resistance would be so distorted or injured by a severe fire as to require complete renewal.

Mow walls and roofs may therefore be of any type of construction that affords protection from the weather, provided the outside cover-

[4] Recommendations relating to the installation and operation of acetylene, gasoline, and other equipment may be obtained upon application to the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

[5] The National Electrical Code may be obtained upon application to the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.

ing, particularly the roof, is of material that will afford protection from sparks or flying brands from another fire. The roof coverings described under "Farmhouses" may be used for barns and all other farm buildings. Water-tightness is to be expected of any roof covering, but it is especially important in a roof over stored hay, which, when wet, is subject to spontaneous ignition.

In the construction of frame or masonry barns all possible barriers to the spread of fire should be provided. The mow floor, if of wood, should consist of at least two layers of 1-inch flooring laid over heavy beams so as to retard the destruction of the floor by a mow fire and prevent the dropping of burning hay into the stable below. The boards of the upper layer should cover the joints of the lower. Better protection would be afforded by a layer of asbestos paper between the layers of flooring. A laminated floor, consisting of 2-inch by 3-inch lumber laid on edge and well nailed together, would provide a much more effective fire barrier.

If the walls or ceiling of the stable are lined, fire stopping as described under "Farmhouses" should be installed to prevent the spread of fire through the joist or stud spaces.

If there is a stairway or ladder hatchway from the lower floor to the mow it should be closed with a fire-resistive door so constructed that it will close of its own weight or be held closed by a wire rope and weight.

All hay chutes should be closed at the ceiling with heavy counterbalanced doors or continued to the stable floor and provided with substantial self-closing doors.

Hay chutes should not be used as ventilating flues for the stable. In cold weather warm moist air from the stable condenses upon the hay in the mow, often rendering it unfit for feeding and causing conditions conducive to spontaneous ignition. Stables should be ventilated by means of insulated flues extending through the mow and connected to ventilator heads at the ridge.

Hay mows should be ventilated by means of slatted openings, open doors, and ventilators in the roof as long as there may be likelihood of the hay heating.

Few barns are provided with means for artificial heating. Where heating is necessary, the construction of the chimney and the installation of the heating unit should be in accord with the recommendations made under "Farmhouses."

Similarly, the installation of electric or other lighting systems should conform to the regulations promulgated by the National Fire Protection Association. Where lanterns are used, substantial safe hooks should be provided in locations convenient for the work to be done but free from the risk of igniting flammable substances.

In 1-story barns the hazard is less than in 2-story barns only to the extent that there is no hay mow, so that all precautions regarding the origin and spread of fire in the stable apply with equal force to the 1-story structure. If hay is stored on the same level as a 1-story barn and adjacent to it, a wall of fire-resistive material should be between them. Such a wall should extend at least 12 inches beyond the side walls and 18 inches above the roof so as to prevent or retard the spread of fire from one part of the structure to the other.

OTHER EXTRA-HAZARDOUS STRUCTURES

Buildings in which automobiles, trucks, tractors, or other power machines are housed are hazardous because the floors generally become oil-soaked and oily rags and rubbish are allowed to accumulate. Cans of oil and grease are often kept in such places, so that the use of open lights, smoking, the careless disposal of matches, or backfiring of the motor are extremely dangerous. Short circuits in the wiring of machines have caused many fires. For this reason special precautions should be observed. Supplies of oil, gasoline, and kerosene should be housed at a safe distance from all buildings and preferably in a fire-resistive or metal-lined shelter. The buildings in which power machines or other hazardous equipment are housed should be built of incombustible material or lined with metal with tight joints so that in case of fire the damage will be confined.

BUILDINGS LESS SUBJECT TO FIRE FROM WITHIN

In many sections of the country hog houses are provided with heating units which, if not properly installed and safeguarded, are a source of danger. The farm shop and other small buildings may contain small heating equipment that may be the cause of a fire resulting in heavy loss by reason of the close proximity of more valuable buildings. Such equipment should be connected with properly constructed chimneys and installed with all protective measures recommended for the farmhouse.

Granaries and other crop storages are not generally subject to destruction by fire from within, but any farm building may be set afire by sparks or brands from another building or from a brush or grass fire and, in turn, may be the cause of the loss of a more valuable building. For this reason all farm buildings should be roofed with incombustible or fire-retardant material. Fire-resistive walls, or wall coverings, afford additional protection and should be employed where buildings are so close together that they constitute a pronounced fire risk.

The construction and precautions discussed in the preceding pages should be provided as means of preventing the starting and spread of fire, but the fire hazard is not eliminated if the premises are not kept clear of dust, cobwebs, and unnecessary accumulations of flammable material, and if rigid measures are not enforced with regard to smoking, carrying of loose matches, housing of flammable liquids, or equipment in which they are used, and other practices that may be even remotely hazardous.

If the construction recommended in this bulletin is carried out, the chances of serious loss by fire will be greatly lessened. If, in addition, there is rigid insistence upon freedom from accumulations of flammable material and strict observance of precautions in the handling of combustibles, the fire hazard will be reduced to the practical minimum. As fire may occur in spite of all precautions, however, fire-fighting equipment should be provided.

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March 15, 1929

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